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Effects of Heating Temperature and Seed Condition on the Yield and Quality of Mechanically Expressed Groundnut Oil

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ABSTRACT: Research has revealed that mechanical expression process could substantially improve the yield and quality of groundnut oil. In this study, experiments were carried out to study the effects of heating temperature and seed condition on the yield and quality of oil extracted from groundnut by mechanical means. The physiochemical analysis of the oil extracted was also determined. Samples of 3kg mass of grounded groundnut seeds were pressed at two different seed conditions (dehulled and undehulled) and four levels of temperatures (70,80,90 and 100^{0}C) in a randomize complete block design (RCBD) and data obtained were subjected to statistical analysis using SPSS software. The result obtained revealed that oil yield increases with increase in temperature but tends to decreases as the temperature increase beyond 90^{0}C and maximum oil yield was obtained when the seeds is in dehulled condition as compared to when the sample was pressed with the hulls. The physiochemical analysis of the oil extracted also revealed that the PH value, specific gravity, refractive index, peroxide value, free fatty acid (FFA) and total acid value of the oil decreases with increase in temperature irrespective of the seed conditions.

Keywords: Groundnuts, Heating temperature, Seed conditions, Oil expression.

1 INTRODUCTION

Vegetable oils and fat has gained popularity in food, cosmetic, soap, pharmaceutical and medical industries for the production of cooking oil and margarine, pomade, toilet soaps, drugs and medical ointment respectively (olaniyan and yusuf, 2012). groundnut protein is increasingly becoming important as food and feed sources, especially in developing countries where protein from animal sources are not within the means of the majority of the populace. the seed has several uses as whole seed or processed to make peanut butter, oil soups, stews and other products. groundnut provides considerable amount of mineral elements to supplement the dietary requirements of humans and farm animals (asibuo et al., 2008). Peanut is an important source of edible oil for millions of people living in the tropics. In Nigeria, 1917 tons of peanuts are being produced annually (Ergül, 1988). Peanuts are among the oldest oil crops in Nigeria and are mostly consumed as snack, after roasting (Bansal et al., 1993; Jambunathan et al., 1993). Vegetable oil had made an important contribution to the diet in many countries, serving as a good source of uv protein, lipid and fatty acids for human nutrition including the repair of worn out tissues, new cells formation as well as a useful source of energy (Gaydou et al., 1983; Grosso and Guzman, 1995; Grosso et al., 1997, 1999). Extraction of oil from oilseeds is an important processing operation. Basically, two methods are used for this purpose. One is solvent extraction method in which a solvent, when brought in contact with the preconditioned oilseed, dissolves the oil present in the seed and the separated mixture is later heated to evaporate the solvent and obtain the oil. The method is highly efficient (over 98% oil recovery) and a single extractor can handle very large capacities (up to 400 tonnes per day). The method, however, requires a large infrastructure with high initial cost and there is a fire and pollution hazard as it requires large quantities of highly flammable solvents (Yusuf, 2012). Oilseeds processing by mechanical means involve a very low initial and operating costs compared to the solvent method of oil extraction and are relatively free of any pollution or fire hazardous substances. This method is widely used for oil expression in the developing countries or for high oil content seeds in combination with a solvent system. Expression is the process of mechanically pressing liquid or liquid-containing solids, screw presses, hydraulic presses, roll presses and mills (such as sugar cane mills), juice extractors, juice reamers collapsible-plate and frame filter, presses are examples of the wide variety equipment available for expression processing

(KHAN AND HANNA, 1983).

The existing traditional method of extraction (known as wet extraction process) involves roasting of the kernels using firewood as fuel, pounding and crushing of the roasted kernels by mortar and pestle or between two stones; mixing the crushed mass with warm water, cooking of the mixed paste in order to obtain the oil by floating; and skimming and drying of the oil by further heating. The method is tedious, time consuming, energy wasting, drudgery-prone, inefficient, and low in yield and poor in quality. Therefore, the objective of this study is to investigate the effects of heating temperature and seed condition on the yield and quality of mechanically expressed groundnut oil.

2. MATERIALS AND METHODS

A spring-controlled hydraulic press used for this study was designed and fabricated in the Department of Agricultural and Bio-systems Engineering, University of Ilorin, Nigeria. The hydraulic press consists of the frame, piston, press cage cylinder, hydraulic jack, collector (tray), return spring, the heater band and a temperature regulatory thermostat as its major components for its efficient operation as shown in Figure 1.

Fig (1): Pictorial View of the Spring-Controlled Hydraulic Press Used for the Study.

The groundnut seeds used for the study were purchased from a produce merchant in Ilorin, kwara State of Nigeria. It was sun-dried from the initial moisture content of 7.5% wb to moisture content of 5.3% wb which is appropriate for oil extraction (Asiedu, 1990). The seeds were divided into two parts; pre-treatment by dehulling of the coat was given to one (Dehulled Condition) while the other part was pressed with the coat (Un-Dehulled Condition)

(a) Dehulled Condition: The seeds after drying were subjected to partial frying for easy remover of the coats. The fried sample was then crushed and winnowed to get rid of coats before it was finally milled for pressing using the plate type attrition mill.

(b) (b)Un-Dehulled Condition: In this condition, the dried sample was milled directly without the removal of the coats using the same attrition mill before pressing operation begins.

2.1 Testing Procedure

The test was carried out using a 2×4×3 factorial experiment. Two conditions of seeds, four levels of temperature at three replications each of which is 3kg per batch was pressed in a Randomized Complete Block Design (RCBD). The physiochemical analysis of oil extracted was carried out for total acid value, free fatty acid, peroxide value, PH value, refractive index and specific gravity.

2.2 Calculations and Statistical Analysis.

The oil extracted and the residual cake were collected and weighed separately. The oil yield was calculated from the data obtained at different temperature using (Tressler and Joslyn, 1961) as reported by (Alonge *et al.,* 2003).

$$OY\ (\%) = \frac{W_{OE}}{W_{OE} + W_{CK}} \times 100\% \qquad (1)$$

OY= Oil yield

W_{OE} =Weight of Oil Extracted

W_{CK} =Weight of Cake

Data obtained were statistically analyzed for Analysis of Variance (ANOVA) and Duncans Multiple range Test using SPSS software. Samples of oil extracted at different temperature were also subjected to physiochemical analysis in order to determine the quality attributes.

3. RESULT AND DISCUSSION

3.1 Oil Yield

The data generated from the calculated values of the average oil yield for both dehulled and undehulled conditions at four levels of temperature are presented in Table 1.

Table 1: Oil Yield from Dehulled and Undehulled Crushed Groundnut Seeds at different Temperatures using the Hydraulic Press

		Temperature (^{0}c)			
Parameters	Condition	70	80	90	100
Oil Yield (%)	Dehulled	19.4± 0.80	22.8± 0.81	24.4± 0.80	23.9±0.80
	Undehulled	15.7±1.37	18.4±1.35	21.1±0.75	23.3±0.00

Each value is the mean of triplicate ± standard deviation

The results of the statistical analysis of variance (ANOVA) for the effects of seed condition and heating temperature on oil yield are shown in Table 2.

Table 2: Analysis of Variance (ANOVA) for the Effect of Seed Condition and Temperature on Oil Yield.

Source	Sum of Squares	DF	Mean Square	F	Sig.
S	54.300	1	54.300	42.326	.000*
T	128.811 3	42.937	33.468	.000*	
S× T	12.758 3	4.253	3.315	.047*	
Error	20.527	16	1.283		
Total	10939.450	24			
Corrected total	216.396 23				

**Significant at P ≤ 0.05; S-Seed Condition; T-Heating Temperature*

The data in Table 2 reveals that the seed condition, heating temperature and their interactions were significant on oil yield at P ≤ *0.05*. Since the temperature and seed condition has effect on the oil yields, Duncan's new multiple range test (DNMRT) was carried out in order to determine the temperature that would yield maximum oil from groundnut using the press.

Table 3: Duncan's New Multiple Range Test (DNMRT) on the Effect of Heating Temperature on Oil Yield.

Heating Temperature (^{0}C)	Oil Yield (%)*
70	17.5833^c
80	20.6333^b
90	22.7500^a
100	23.5833^a

**means with the same letter are not significantly difference but means with different letters are significantly different at 5% confidence level.*

The Duncan's New Multiple Range Tests (DNMRT) (Table 3) shows the degree of significant differences in each of the factors and interaction between them. The analysis shows that the temperatures have significant effect on oil yield at 5% confidence level. Table 3 also reveals that there is no significant difference from the oil obtained from the seeds at temperature of 90 and 100^{0}C.

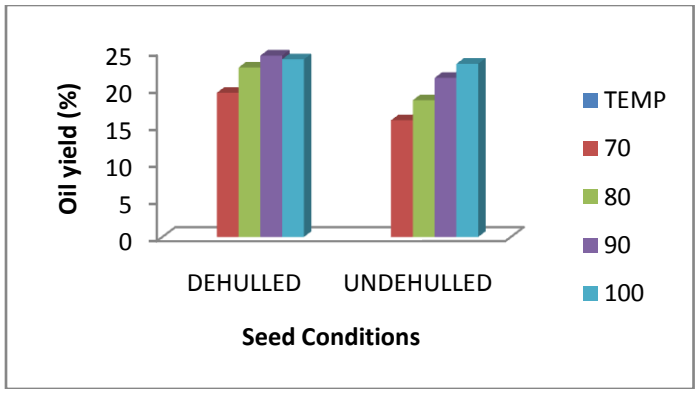


Figure: 2(a) Effect of Seed condition on Oil Yield

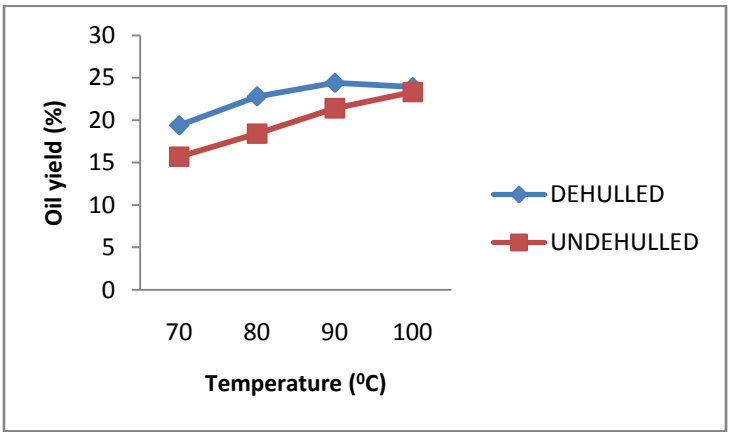


Figure:2(b) Effect of Heating Temperature on Oil Yield

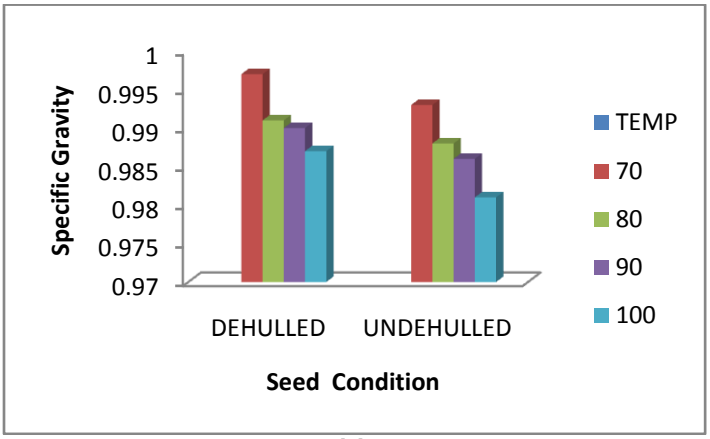
3.1 Quality Analysis of the Oil Extracted

The quality evaluation of the oil extracted was carried out at the Chemistry Department, University of Ilorin, Nigeria to know the effects of seed conditions and heating temperature on the quality of oil extracted. The parameters considered include the PH value, specific gravity, refractive index, free fatty acid (FFA), Peroxide value and total acid value of the oil.

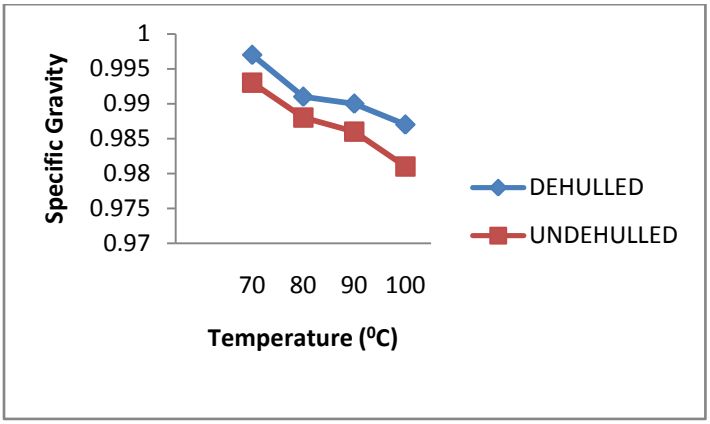
Table 4: Quality Characteristics of the Oil Extracted

Temp (^{0}C)	parameters					
	S	PHV*	TAV*	SG*	FFA*	PV*
	RI*					
70	D	6.91	12.91	0.997	6.752	9.992
	1.479					
	U	6.97	12.91	0.993	6.822	9.982
	1.482					
80	D	6.93	12.84	0.991	6.532	9.972
	1.471					
	U	6.80	12.91	0.988	6.731	9.962
	1.473					
90	D	6.95	12.78	0.990	6.412	
	9.961	1.463				
	U	6.82	12.91	0.986	6.599	
	9.944	1.469				
100	D	6.98	12.62	0.987	6.311	
	9.940	1.453				
	U	6.89	12.90	0.981		6.451
	9.910	1.460				

** Each value is the mean of triplicate of PH value (PHV), Total Acid Value (TAV), Specific Gravity (SG), Free Fatty Acid (FFA), Peroxide Value (PV) and Refractive Index (RI); S-Seed Condition, D-Dehulled, U-Undehulled*

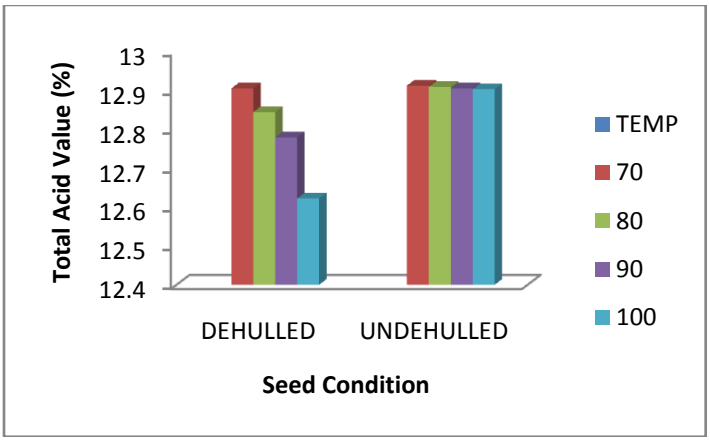


(a)

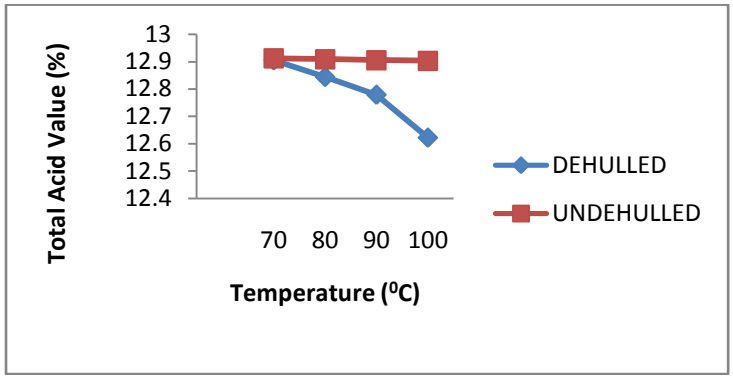


(b)

Fig. 3. Effects of Seed Condition (a) and Heating Temperature (b) on the Specific Gravity of Oil Extracted

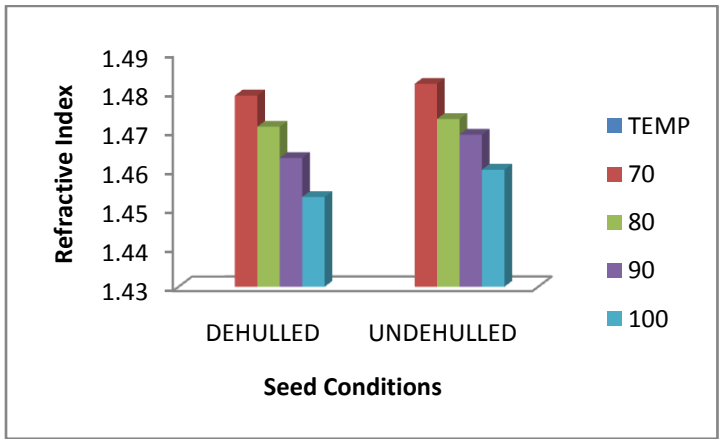


(a)

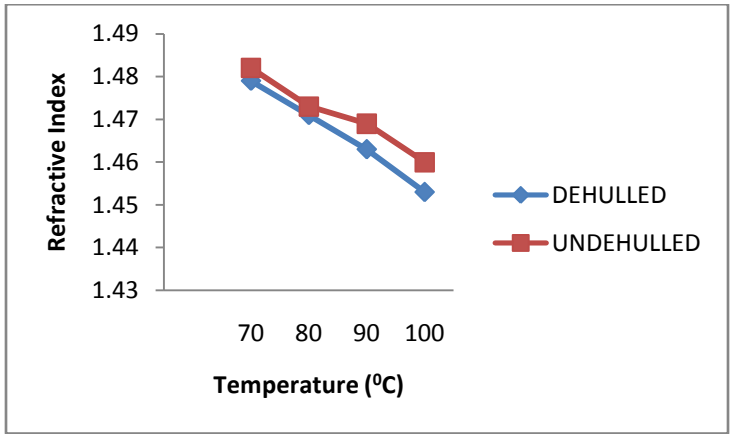


(b)

Fig. 4. Effects of Seed Condition (a) and Heating Temperature (b) on the Total Acid Value of Oil Extracted

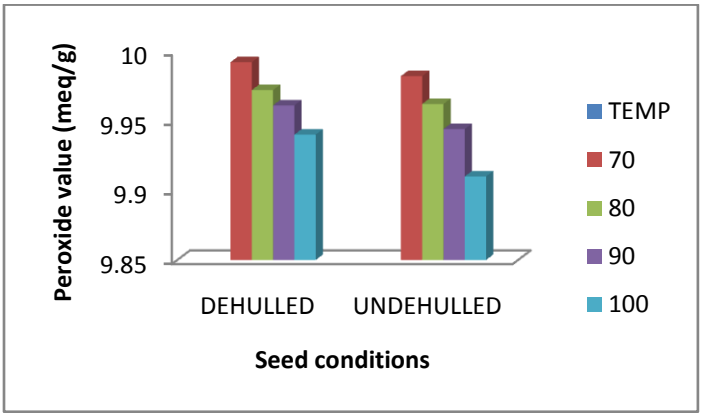


(a)

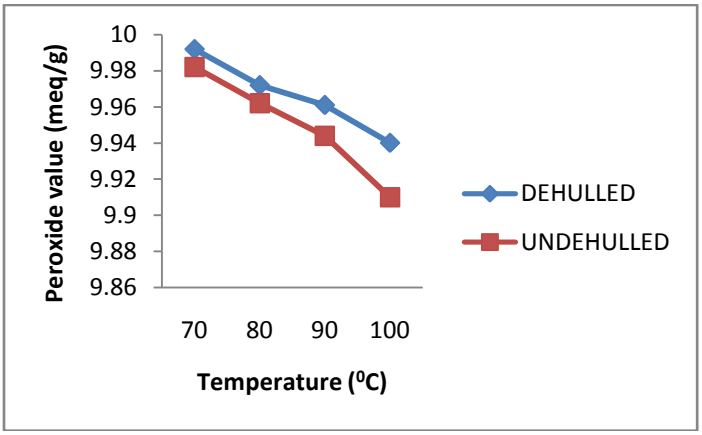


(b)

Fig. 5. Effects of Seed Condition (a) and Heating Temperature (b) on the Refractive Index of Oil Extracted

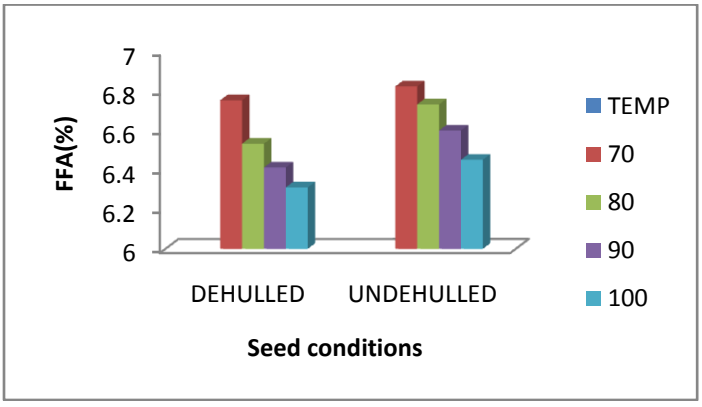


(a)

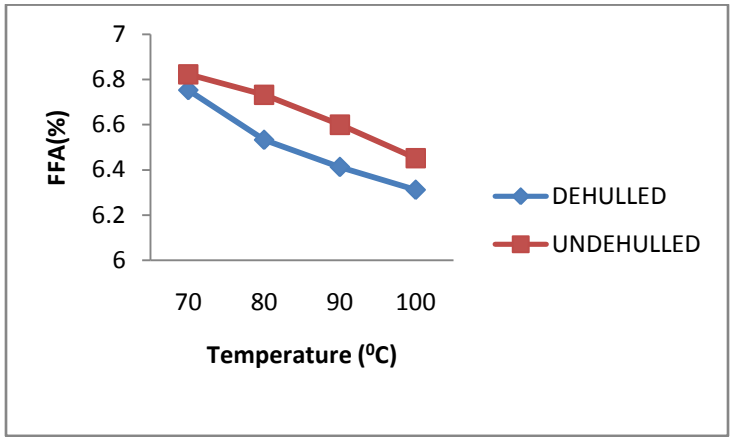


(b)

Fig.6. Effects of Seed Condition (a) and Heating Temperature (b) on the Peroxide Value of Oil Extracted

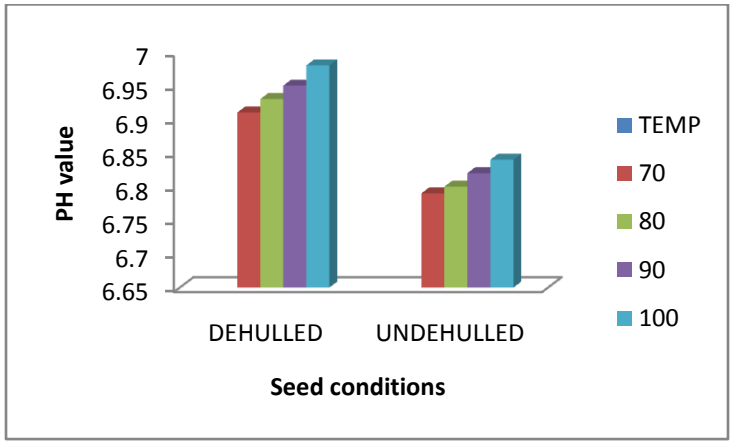


(a)

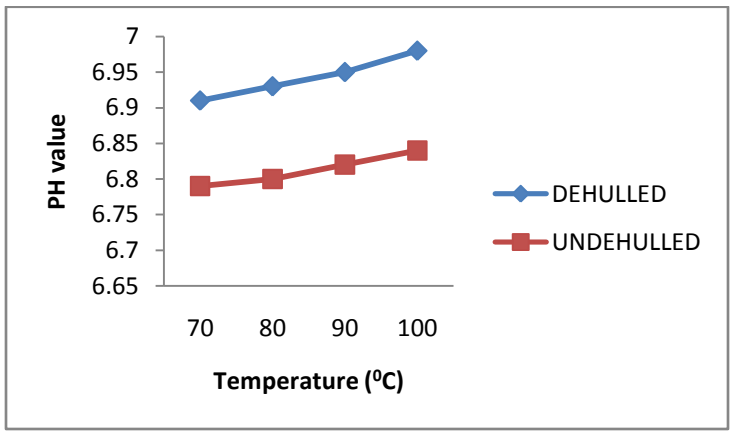


(b)

Fig.7. Effects of Seed Condition (a) and Heating Temperature (b) on the FFA of Oil Extracted



(a)



(b)

Fig.8. Effects of Seed Condition (a) and Heating Temperature (b) on the PH Value of Oil Extracted

4. CONCLUSION

The experiment revealed that the oil yield increases with increase in heating temperature but tends to decrease as the temperature increases from 90 to 100^{0}C. Also, the quantity of

oil obtained when the seed were in Dehulled condition was higher as compared to when it is Undehulled at the same heating temperatures. the quality analysis of the oil extracted also revealed that the quality of oil extracted with temperature of 90^0C when the seeds were in Dehulled condition has 6.95, 6.412, 9.961,1.463, 12.779 and 0.990 as its PH value, Free Fatty Acid (FFA), Peroxide value, Refractive Index, Total acid value and Specific gravity respectively.

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